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Agri-fintech: Transforming agriculture finance through digital lending, crop insurance, and farmer adoption

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Abstract

Timely finance is essential for agricultural production, investment and risk management. Agri-Fintech is changing conventional financial processes through digital lending, crop insurance, verification and payments. This study examines its role in agricultural finance in Raigad district of Maharashtra using data from 59 smartphone-using farmers and 30 banking and Agri-Fintech respondents collected in 2026. Percentage analysis, Likert-scale analysis and the Wilcoxon Signed-Rank Test were used. Institutional results showed significant improvements after digital adoption, including faster farmer verification and higher crop-insurance penetration, which increased from 44.50 to 61.47 percent. Lending efficiency also improved across six indicators. Among farmers, digital-service awareness was higher than actual usage. Fraud concerns, high charges and poor internet connectivity were major barriers. The study highlights the need for secure, affordable services and practical digital support.

Keywords: Agri-Fintech; Digital Lending; Crop Insurance; Financial Inclusion; Farmer Adoption; Digital Financial Services; Rural Finance

Introduction

Agriculture is an important part of the rural economy, and farmers require financial resources at different stages of the agricultural production cycle. Expenditure is incurred on seeds, fertilizers, labour, irrigation, machinery, harvesting, storage and marketing. Along with these expenses, farmers face several risks, including unpredictable weather, crop losses, pest and disease outbreaks and fluctuations in market prices. Agricultural finance, therefore, is not limited to providing funds. It also involves making financial services affordable, dependable, accessible and available when farmers need them. Traditionally, agricultural financial services have been provided by commercial banks, cooperative institutions, Regional Rural Banks, insurance companies and NBFCs. These services have often depended on documentation, physical verification and conventional credit-assessment procedures. Such processes can take considerable time and may be particularly difficult for farmers living in rural areas. The increasing availability of smartphones, mobile internet and digital platforms has encouraged the development of Agri-Fintech as a way of improving agricultural financial services. Its applications include digital lending, crop-insurance services, electronic customer verification, automated credit assessment and data-based financial support.

Evolution of Digital Agricultural Finance

Digital agricultural finance has developed gradually through the transformation of conventional financial systems. The shift from traditional banking to electronic banking, the digitization of financial records, the expansion of Direct Benefit Transfer systems, digital identity infrastructure and electronic payment mechanisms have all contributed to this transition. The growing availability of mobile connectivity has further accelerated the process. Digital payment platforms such as UPI, along with electronic customer-verification systems and other digital financial infrastructure, have created additional ways for financial institutions to provide services to customers. As a result, interactions between financial institutions and customers are no longer dependent entirely on branch visits and paper-based procedures.

In agriculture, this transition creates opportunities to make financial services more accessible to farmers who may otherwise face geographical, procedural or administrative difficulties. Digital systems can potentially reduce the need for repeated physical visits and make certain financial processes faster and more convenient. These developments have contributed to the growing role of technology in agricultural finance.

Background and Research Gap

Agricultural finance has an important practical requirement: financial services need to reach farmers at the right time and through procedures that are simple, dependable and easy to access. Delays in receiving credit or completing insurance-related processes can create difficulties for farmers because agricultural activities are closely linked to crop seasons and production schedules. The present study therefore considers the issue from two perspectives. At the institutional level, it examines whether digitalization is associated with measurable changes in the efficiency of agricultural financial operations. At the farmer level, it examines whether these developments are reflected in awareness and actual use of digital financial services. Existing literature has examined various aspects of financial inclusion, FinTech, digital banking, financial literacy and rural financial services. Earlier studies have also generally approached digital financial inclusion and FinTech from a broader perspective. Fewer studies have directly compared operational measures before and after the adoption of digital systems in agricultural finance. The present study attempts to address this gap by combining institutional and farmer-level evidence from Raigad district of Maharashtra. This approach provides a broader understanding of Agri-Fintech by examining both changes in institutional operations and the extent to which farmers are aware of and actually use digital financial services.

Need and Scope of the Study

The need for this study is closely related to the time-sensitive nature of agricultural finance. Farmers require financial resources at specific stages of crop production, and delays in obtaining credit may affect the purchase of inputs and the timely completion of farm operations. Crop insurance also involves time-bound activities because enrollment, documentation and verification generally need to be completed within specified periods. The study focuses on both farmer-level and institutional aspects of agricultural finance in Raigad district of Maharashtra. The farmer component covers 59 smartphone-using farmers from different villages. It examines their awareness of digital financial services, their actual use of these services and the barriers that may prevent adoption. The institutional component includes 30 respondents from banking and Agri-Fintech institutions. It examines the availability of digital financial services and assesses changes in selected operational indicators before and after digital adoption. These indicators include farmer-verification efficiency, crop-insurance penetration and different aspects of agricultural lending efficiency. By examining both groups, the study provides a combined view of the development of Agri-Fintech. It considers not only whether digital systems can improve institutional processes but also whether farmers are sufficiently aware of and able to use these services.

Objectives of the Study

1. To assess the impact of FinTech innovations on crop insurance penetration and verification efficiency.
2. To measure the reduction in loan processing times and costs using digital lending models in agriculture.
3. To assess awareness among farmers regarding Agri-Fintech services and platforms.
4. To identify key barriers to Agri-Fintech adoption.

Hypotheses

Null hypothesis: FinTech innovations have no significant impact on crop insurance penetration and farmer verification efficiency.

- **Alternative hypothesis:** FinTech innovations have a significant positive impact on crop insurance penetration and farmer verification efficiency.
- **Null hypothesis:** There is no significant reduction in loan processing time and processing cost after adoption of digital lending models in agriculture.
- **Alternative hypothesis:** There is a significant reduction in loan processing time and processing cost after adoption of digital lending models in agriculture.

Review of Literature

Financial inclusion and agricultural finance are closely linked. The literature reviewed in the study indicates that education, age, income, landholding size and financial literacy can shape financial inclusion. The FinTech literature adds another dimension to financial inclusion by looking at technology as a means of making financial services more accessible and reducing transaction-related difficulties. Reviews of Indian FinTech identify mobile banking, digital payments, UPI, IMPS, mobile wallets, QR codes, peer-to-peer lending, blockchain and artificial intelligence as parts of the broader digital financial ecosystem. Rural studies further indicate that accessibility, digital financial literacy and ease of use can influence FinTech adoption, while inadequate infrastructure, regulatory limitations and security concerns can discourage users. FinTech, Agricultural Lending and Crop Insurance Digital lending can influence several stages of the loan process. Electronic documentation and automated processing may reduce dependence on physical paperwork and can affect document verification, underwriting and overall turnaround time. Technology can also be applied to crop insurance through mobile-based enrollment, digital customer verification and geospatial information. These mechanisms may support registration and verification processes and reduce some administrative difficulties.

Research Gap Emerging from the Literature

The existing literature provides considerable support for the role of FinTech in improving financial inclusion, but several areas remain less explored in an agricultural context. First, there is limited agricultural-specific evidence directly connecting digital financial systems with crop-insurance penetration and the speed of farmer verification. Second, relatively little direct before-and-after evidence is available on changes in agricultural loan-processing efficiency and processing costs following digital adoption. A further issue concerns the difference between awareness and actual use

Research Methodology

Research Design

The study employed exploratory and descriptive research designs. The exploratory approach was used for the farmer survey because awareness and adoption are influenced by perceptions, familiarity with technology and personal experience. The descriptive approach was used for the institutional survey because it collected structured information on service availability, processing timelines and administrative costs.

Area of Study

The study was conducted in Raigad district of Maharashtra. The district provides a relevant setting for examining agricultural finance because its agricultural economy is influenced by coastal conditions and dependence on the monsoon. Crops such as paddy and horticultural crops are important in the area. These characteristics make timely access to credit and crop insurance particularly relevant to farming households.

Sampling Design

The first respondent group consisted of 59 smartphone-using farmers selected from different villages of Raigad district. The sample included respondents with differences in age, educational background and landholding size. The second group consisted of 30 respondents from banking and Agri-Fintech institutions, including branch managers, loan-evaluation officers, agricultural field supervisors and technical staff involved in agricultural lending and crop-insurance-related activities.

Sources and Collection of Data

Primary data were collected during 2026 using structured questionnaires and direct interaction with respondents. Separate questionnaires were prepared for farmers and institutional respondents. Google Forms were used where respondents were geographically dispersed. The farmer questionnaire covered demographic characteristics, smartphone use, awareness of FinTech and digital crop insurance, knowledge of digital agricultural loans, actual use of digital services and barriers to adoption. A five-point Likert scale was used for adoption-barrier statements. The institutional questionnaire collected information about organization type and the availability of digital crop-insurance enrollment, digital customer verification, agricultural loans and digital lending systems. It also included before-and-after measures relating to operational performance. Secondary information was obtained from government reports, academic articles, journals, books, official institutional sources and other relevant literature.

Variables and Analytical Tools

Categorical variables were used for demographic characteristics and service-awareness analysis. Ordinal responses were used to measure adoption barriers, while paired before-and-after observations were used to examine changes in institutional efficiency. The main analytical methods were percentage analysis, Likert-scale analysis and the Wilcoxon Signed-Rank Test.

Percentage Analysis

Percentage = (Number of respondents in a category / Total number of respondents) × 100

Likert-Scale Analysis

A five-point Likert scale was used to assess barriers affecting Agri-Fintech adoption. Responses were coded as Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5). The weighted mean was calculated as: $\text{Likert Mean Score} = \sum(f_i \times S_i) / N$, where f_i is the frequency of responses and S_i is the corresponding score.

Wilcoxon Signed-Rank Test

The Wilcoxon Signed-Rank Test was applied to paired institutional observations. The same 30 institutional observations provided information for both before and after periods, making a paired non-parametric test suitable. For each pair, the difference was calculated as $D_i = \text{After}_i - \text{Before}_i$. A p-value below 0.05 was treated as evidence of a statistically significant difference.

Results

Socio-Demographic Profile of Farmers

The farmer survey included 59 respondents. The gender distribution comprised 22 males (37 percent), 13 females (22 percent) and 24 respondents who selected “Prefer not to say” (41 percent). Because this was the largest category, the figures were used primarily to describe sample composition rather than to draw conclusions about gender-based differences.

Table 1: Gender of respondent Gender No. of respondents Percentage

Male	22	37
Female	13	22
Prefer not to say	24	41
Total	59	100

Table 2: Age of respondent

Age group	No. of respondents	Percentage
Below 25	11	19
25–35	11	19
36–45	13	22
46–55	17	29
Above 55	7	12
Total	59	100

The respondents represented all specified age groups. Farmers aged 46–55 years formed the largest group at 29 percent. Overall, 60 percent of respondents were aged 45 years or below.

Table 3: Education profile

Education	No.	percentage
No formal education	2	3
Primary	9	15
Secondary	15	25
Higher Secondary	16	27
Graduate	16	27
Postgraduate	1	2

Landholding Profile

Landholding size varied across the sample. Farmers with holdings of 4–10 hectares represented the largest group at 29 percent, followed by those with 2–4 hectares at 25 percent. Holdings below 1 hectare accounted for 17 percent, while 15 percent had 1–2 hectares and 14 percent had more

than 10 hectares. This variation provides context for differences in agricultural financial requirements.

Services Provided by Financial Institutions

The institutional survey included respondents from different types of organizations involved in agricultural finance. Cooperative banks accounted for 33 percent of the institutional sample, followed by commercial banks at 23 percent. NBFCs represented 17 percent, Regional Rural Banks 13 percent, and Agri-Fintech and insurance companies 7 percent each.

Table 4: Services Provided

Service	Yes (%)	Partially (%)	No (%)
Digital customer verification for crop insurance	60	27	13
Mobile-based crop-insurance enrollment	83	13	3
Digital platform for crop-insurance enrollment	70	17	13
Digital lending system for agricultural loans	60	23	17
Agricultural loans	90	0	10

Agricultural loans were the most widely available service, reported by 90 percent of institutions. Mobile-based crop-insurance enrollment was available in 83 percent, digital crop-insurance platforms in 70 percent, and digital customer verification and digital agricultural lending systems in 60 percent each. Digital transformation was not uniform; some processes remained hybrid or manual.

Impact of FinTech on Crop Insurance Penetration and Verification Efficiency

Paired observations were collected from 30 institutional respondents to compare reported conditions before and after digital adoption. The Wilcoxon Signed-Rank Test was used to determine whether the observed changes were statistically significant.

Table 5: Indicators Before and After Digital Adoption

Measure	N	Before mean	After mean	Z	p-value
Verification-time rating	30	3.00	2.00	-4.524	<0.001
Farmers insured (%)	30	44.50	61.47	-4.786	<0.001

The mean verification-time rating declined from 3.00 before digital adoption to 2.00 after adoption. The Wilcoxon result was $Z = -4.524$ with $p < 0.001$, indicating a statistically significant change at the 5 percent level. The direction of change indicated improved verification efficiency following digital adoption. The mean percentage of insured farmers increased from 44.50 percent before digital adoption to 61.47 percent after adoption, an increase of 16.97 percentage points. The Wilcoxon test produced $Z = -4.786$ and $p < 0.001$, indicating a statistically significant difference. The result showed a positive association between the reported use of digital insurance mechanisms and crop-insurance penetration among the institutions covered. These findings suggest that digital enrollment and verification mechanisms may help institutions process insurance-related activities more efficiently while potentially reaching a larger proportion of farmers.

Impact of Digital Lending Models on Loan Processing Efficiency

Six operational indicators were examined using responses from 30 institutional respondents. Mean efficiency scores before and after implementation of digital lending workflows were compared using the Wilcoxon Signed-Rank Test.

Table 6: Institutional lending-efficiency indicators before and after digital adoption

Indicator	Before mean	After mean	Z-value	P-value
Loan Processing Time	3.53	4.67	-4.540	<0.001
Document Verification Time	3.07	3.87	-4.179	<0.001
Underwriting Time	3.83	4.60	-3.097	0.002
Approval-to-Disbursement Time	4.50	5.10	-3.819	<0.001
Total Turnaround Time	3.33	4.40	-4.725	<0.001
Processing Cost	2.90	3.77	-4.099	<0.001

Loan-processing efficiency increased from a mean score of 3.53 before digital adoption to 4.67 after adoption. Document-verification efficiency increased from 3.07 to 3.87. Underwriting efficiency increased from 3.83 to 4.60. Approval-to-disbursement efficiency increased from 4.50 to 5.10, total turnaround-time efficiency from 3.33 to 4.40, and processing-cost efficiency from 2.90 to 3.77.

All six p-values were below 0.05. The null hypothesis of no significant change was therefore rejected for each indicator. The findings indicated statistically significant improvements in the institutional efficiency ratings associated with digital lending workflows.

Discussion

Farmer Awareness of Agri-Fintech Services

The farmer-level results showed that respondents were more familiar with particular digital financial services than with the technical term “FinTech.” Only 39 percent were familiar with the term FinTech. Awareness was higher when questions focused on specific functions: 75 percent knew that digital channels could provide faster credit and 61 percent were aware of digital payments.

Practical knowledge was stronger. Seventy-six percent knew how to purchase crop insurance digitally, and 69 percent knew how to apply for an agricultural loan through a mobile or online application. This difference indicates that farmers may understand the purpose of a service and know how to access it without identifying it as FinTech.

Table 7: Awareness among Farmers

Awareness factor	Yes	Yes (%)	No	No (%)
Aware of term FinTech	23	39	36	61
Aware of digital crop insurance	23	39	36	61
Aware digital channels can provide faster credit	44	75	15	25
Aware of digital payments	36	61	23	39
Know how to purchase crop insurance digitally	45	76	14	24
Know how to apply for agricultural loan digitally	41	69	18	31

Actual Use of Digital Financial Service

Table 8: Serviced Used By Farmers

Service used	Yes response	Yes (%)	No response	No (%)
Digital crop insurance	11	19	48	81
Digital agricultural loan	14	24	45	76
Digital payments	14	24	45	76

Only 19 percent of farmers had used a digital platform to purchase or manage crop insurance. Digital agricultural loans and digital payments for the stated farming activities were each used by 24 percent. Thus, more than three-fourths of the smartphone-using farmers were not regularly using these digital financial services. The difference between awareness and actual adoption was a central finding.

Interpretation of the Awareness–Adoption Gap

The findings point to three connected stages in the digital-finance process: availability of the service, awareness and practical knowledge, and actual adoption. The institutional survey showed relatively high availability for several digital services. The farmer survey also showed substantial awareness of specific digital functions. Yet actual use remained considerably lower.

Several factors may contribute to this gap, including security concerns, service charges, connectivity problems, limited confidence in using applications and continued preference for receiving assistance during financial transactions. The results indicate that creating digital platforms alone does not ensure regular farmer adoption.

Key Barriers to Agri-Fintech Adoption

Table 9: Key Barriers in Adoption

Barrier statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Trust in Platforms	15	35	4	3	2
High Fees / Service Charges	0	6	8	30	15
Insufficient application knowledge	16	19	0	14	10
Poor Internet Connectivity	9	9	5	15	21
Fear of Fraud/Hacking/Misuse	0	5	8	25	21

Fear of fraud, hacking or misuse of personal information was the most prominent concern. Forty-six respondents, or 78 percent, agreed or strongly agreed that this issue discouraged them from using digital financial services. High fees or service charges were reported by 45 respondents (76 percent), while poor internet connectivity was reported by 36 respondents (61 percent).

Insufficient knowledge of smartphone applications was a comparatively moderate constraint: 24 respondents (41 percent) agreed or strongly agreed that they lacked sufficient knowledge. The trust statement was framed around lack of trust in digital platforms; only 5 respondents (8 percent) agreed or strongly agreed, whereas 50 respondents (84 percent) disagreed or strongly disagreed.

Discussion in Relation to Earlier Studies

The findings complement earlier work emphasizing financial inclusion and financial literacy among farmers. The present results add another dimension by showing that awareness of individual digital services does not necessarily

result in actual adoption. The institutional findings add an agricultural operational perspective by showing statistically significant changes in verification and lending processes following digital adoption. The farmer-level findings correspond with literature identifying digital financial literacy, accessibility, infrastructure and security as important factors affecting FinTech adoption in rural India.

Conclusion

The study showed that Agri-Fintech can influence the delivery of agricultural financial services. Institutional findings indicated improvements in verification efficiency, crop-insurance penetration and the efficiency of major lending activities following digital adoption. The statistically significant before-and-after results provided evidence of meaningful changes within the institutions covered by the study. At farmer level, having a digital service available did not automatically mean that farmers would use it. A gap existed between institutional service availability, farmer awareness and actual adoption. Farmers were often familiar with practical services such as digital crop insurance and online agricultural loans without necessarily knowing the term FinTech. Even with practical awareness, actual usage remained comparatively low. The main barriers were concerns about fraud and hacking, service charges and poor internet connectivity. These findings suggest that technology alone cannot drive adoption. Farmers also need services that are safe, affordable and dependable, together with practical guidance and accessible support

Suggestions and Policy Implications

1. Practical digital training. Financial institutions and agricultural extension networks should organize village-level demonstrations showing farmers how to apply for digital agricultural loans, purchase crop insurance, complete customer verification and make digital payments. The emphasis should be on step-by-step practice rather than technical terminology.
2. Local-language support. Digital platforms and training materials should be available in languages farmers are comfortable using. Voice-based guidance, visual instructions and assisted application facilities can improve accessibility.
3. Strengthen cybersecurity and fraud awareness. Because fraud and hacking concerns were prominent, institutions should strengthen authentication and transaction monitoring and provide practical guidance on phishing, fraudulent messages and suspicious calls. Accessible grievance mechanisms should be available for failed or suspicious transactions.
4. Reduce and disclose charges. Banks and FinTech providers should clearly disclose applicable charges before transactions and avoid unnecessary platform or transaction fees.
5. Improve rural connectivity. Government agencies, telecom providers and financial institutions should work towards better mobile and internet connectivity in farming areas. Applications should function reliably in low-bandwidth conditions.
6. Use trusted intermediaries. Farmer Producer Organizations, cooperatives, banking correspondents and agricultural extension networks can act as assisted-

- digital access points. Such assistance can guide farmers without replacing their control over transactions.
7. Strengthen digital insurance adoption. Digital insurance enrollment should be connected with awareness activities, claim-status information and assisted verification so farmers understand both enrollment and post-enrollment processes.
 8. Integrate farmer feedback. Banks and FinTech companies should regularly collect feedback about usability, failed transactions, charges, connectivity and security concerns and use it to improve products.
 9. Monitor adoption beyond access. Digital initiatives should be assessed through actual farmer usage, successful application completion, turnaround time, transaction failures, grievance resolution and continued use rather than only the number of platforms introduced.
 10. Encourage collaboration. Agri-Fintech development involves financial institutions, technology providers, government agencies, agricultural extension systems and farmer organizations. Coordinated approaches can help align institutional digitalization with farmer needs

Limitations and Future Research

The study was conducted in one district and used a relatively small sample of 59 farmers and 30 institutional respondents. The farmer component was limited to smartphone-using respondents, so the findings should not be generalized to all farmers. The institutional analysis used reported efficiency ratings rather than transaction-level administrative data. Future research could use larger multi-district samples and transaction-level records to estimate actual changes in processing time and cost more precisely.

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Conflict of Interest

The authors declare that there is no conflict of interest related to this work.

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